TULANE STUDIES IN ZOOLOGY AND BOTANY

Vol. 20 Nos. 1-2 $3.00 January 9, 1978

A NEW SPECIES OF *EURYCERCUS* (CLADOCERA, CHYDORIDAE) FROM THE SOUTHERN UNITED STATES[1]

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ABSTRACT

Two species of *Eurycercus* occur in the southern United States, of which *E. microdontus* in the subgenus *Eurycercus* is described here. Its outstanding characteristic is that the large number of minute teeth on the postabdomen exhibits a sigmoid relationship to size of animal, rather than linear as in the other known species. Moreover, although the two major populations from North Carolina and Florida agree very closely in most morphological details, they differ significantly in this regression and in the body size at which reproduction begins. The meaning of these differences in terms of evolution within the genus is not yet understood. Other characters that are size-dependent, particularly details of setation and spinulation on trunk limbs I and II, are described by regressions and compared with the other species. Relatively little can be deduced concerning the biology of the species because of the small size samples available.

INTRODUCTION

Two species of the highly distinctive genus *Eurycercus* occur in the south and southeastern region of the United States and south at least to Mexico City. Neither is the species *E. lamellatus,* which is the only one presently reported as occurring in the United States, excluding Alaska (Brooks 1959). Until recently (Frey 1971) *E. lamellatus* was considered to be widespread over North America and Eurasia, with disjunct populations in Argentina and South Africa. Now (Frey 1973, 1974) this taxon is known to be made up of a number of species, each with a much more restricted distribution. *E. lamellatus* sensu strictu is the dominant, and probably in most water bodies the only, species in Western Europe and for an unknown distance eastward through the northern half of Asia. Evidence to date suggests it does not occur in North America at all.

The most outstanding characteristics of the nominate subgenus to which *E. lamellatus* sensu strictu belongs are a sharp keel on the shell in all instars and a pronounced transverse fold or notch immediately behind the median head pore (Frey 1974). Moreover, the keel actually begins on the head shield behind the median pore, which results in a triangular posterior extension of the head shield where it contacts the keel on the shell. The original paper on head shields and head pores of the chydorid Cladocera (Frey 1959) contains a sketch of a *Eurycerus* head shield from White Lake, N. C., having the same triangular extension posteriorly as in the European taxon and hence at that time judged to be the same. This was an unfortunate coincidence that may have delayed the recognition of the plurality of *Eurycercus* for some years, because from almost any other region of North America, particularly from the more northern lake districts in the

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United States and Canada where *Eurycercus* is a common component of the littoral fauna, the head shields are rounded behind. Close examination of intact specimens of these populations would have revealed an unkeeled shell and the head pore located on a rounded protuberance – features that are characteristic of the subgenus *Bullatifrons* (Frey 1974) to which the second species in the South and Southeast belongs. Studies have not yet been made to determine if this latter species is the same as the widespread *Bullatifrons* sp. to the north, although superficially they seem different. Resolution of this matter will have to be delayed until the description of the northern taxon has been completed. Except for matters of distribution, the present paper is concerned only with *Eurycercus microdontus* sp. nov.

DISTRIBUTION

The region under consideration comprises the 11 states from North Carolina west to Oklahoma and south to Florida and the Gulf of Mexico plus Mexico. Here *Eurycercus,* although obviously widespread, is very sporadic in occurrence and seldom abundant, except perhaps in winter to late spring. The subgenus can be determined only from actual specimens. None of the literature records, including the lengthy description of Chien (1969), provides any basis for deciding the subgenus. Specimens derive chiefly from my own collections in North Carolina, Tennessee, Florida, Mississippi and Louisiana and from the sediment samples collected by DeCosta (1964). Scattered specimens were discovered in the U. S. National Museum and the E. A. Birge collection. Collections made in various states by R. V. Harmsworth, W. M. Lewis, Jr., P. R. Becker, Dewey Bunting, D. L. Dycus, D. C. Wade, and F. N. Young yielded occasional specimens or exuvial fragments. All known occurrences of the genus in this region are summarized in Tables 1 and 2 and Figure 1.

DeCosta (1964) found the remains of *Eurycercus* in the sediments of 7 out of 22 lakes sampled from Reelfoot Lake, Tennessee, to New Orleans, generally in very low abundance. Chien (1969) recovered *Eurycercus* from only 3 samples out of 80 collected along the entire length of the Pearl River in Mississippi and always in his lowest category of abundance. The only record from Texas is one intact specimen from Smithville in the E.A. Birge Collection. Intensive faunistic effort, documented by a number of master's theses from several universities in the State, have not disclosed any additional records (Becker and Sissom 1971).

For *Eurycercus microdontus* described in this paper (Table 1), the original material consisted of head shields and postabdomens from Pages Lake and White Lake in North Carolina, plus a few intact specimens and exuvial fragments from four lakes in Highlands Co., Florida, near the southern tip of the interior lake district. The Florida lakes were revisited in early December 1972 for the express purpose of obtaining more specimens and hopefully gamogenetic individuals. Intensive sampling yielded a total of only 70 specimens from Lake June in Winter, a few specimens each from two of the other lakes, and none at all from the fourth. No gamogenetic individuals were collected. More than 30 samples in the D. G. Frey Collection from various lakes in North Carolina, South Carolina, Georgia, Florida, Louisiana, Texas, and Mexico were searched for *Eurycercus* with completely negative results, except for an offshore sample of benthic algae from White Lake, N. C., which yielded the second largest collection of this taxon. The fairly extensive collection of D. L. Dycus from Georgia was not used in the morphological analysis because all specimens are badly distorted from preservation. Other records are based on scattered specimens and exuviae.

Fortunately, the raw sediment samples from all the lakes studied by DeCosta (1964) and from a few additional ones not used in his study have been stored in glass jars in a 5° room at Indiana University. Samples from his seven positive lakes in this region were processed, plus Sardis Reservoir, Miss., and Lake Charles, La., known to be positive on other evidence, plus three negative lakes that were significant to reexamine for one reason or another, and also Johnson's Lake, Tenn. Processing consisted of deflocculating 30-50 cc of raw sediment in 10% NaOH on a magnetic stirrer-hotplate (temperature kept below boiling) for about 1 1/2 hours. The sediment was then screened through a Clarke-Bumpus bucket provided with a No. 18 metal screen, which is fine enough to retain headshields and postabdomens of even the first-instar individuals of the two species of *Eurycercus*. Fractions of the residue were scanned systematically in a petri dish at a magnification of 15 X. Remains of *Eurycercus* were picked out as encountered and subsequently mounted in polyvinyl-lactophenol stained with lignin pink for study at higher magnifications. The results are given in Table 3.

Remains of *Eurycercus* were recovered from all of DeCosta's positive lakes, except Horseshoe Lake, La., from which he had recovered only a single fragment. Remains were also recovered from Sardis Reservoir and Lake Charles. All head shields, except three from Bennett's Bay in Lake Cocodrie, La., were from the subgenus *Bullatifrons*. The single *Bullatifrons* head shield from Lake Charles is interesting, because the specimen from this locality in the E. A. Birge collection is *E. microdontus*. Accordingly, another 50 cc of sediment was processed without disclosing any more remains of either species, demonstrating how very tenuous even some of the positive records can be. No remains of the genus were recovered from Alligator Lake and Lake Concordia in Louisiana, from the lagoon in Audubon Park, New Orleans, or from Johnson's Lake, Tenn.

A trip to some of the southern states was made in May 1974. *Bullatifrons* sp. was found at two of Chien's (1969) three *Eurycercus* stations in the Pearl River System, Miss., at Reelfoot Lake, Tenn., and at Courtebleau Bayou, La. (see Table 2). In addition, collections from various TVA reservoirs were examined at Muscle Shoals, Ala. No new populations of *E. microdontus* were discovered.

Aside from Lake Charles, which may be doubtful because of the 60 years between the records for the two species, both species

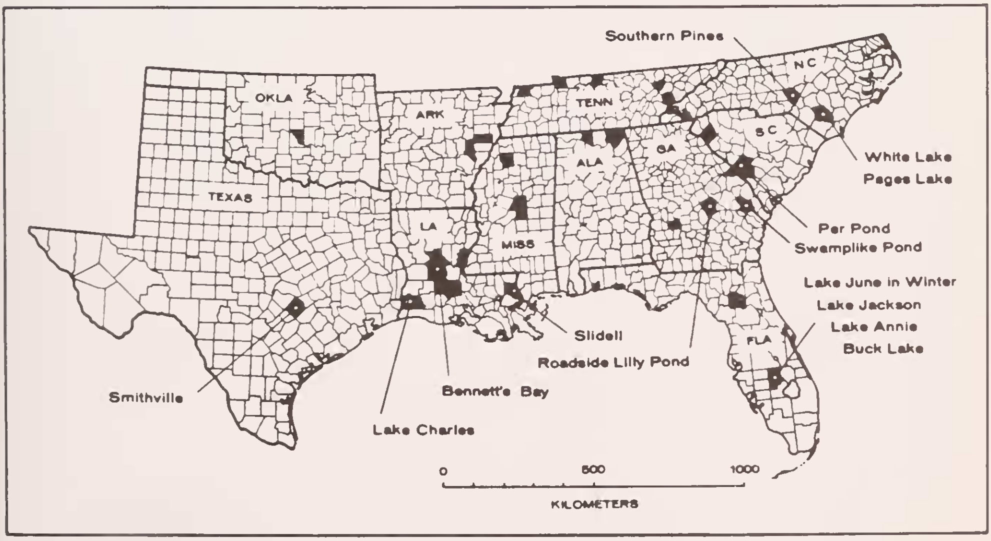


Figure 1. Known distribution by counties or parishes of the two species of *Eurycercus* in the southern and southeastern part of the United States. In addition there is a record from Mexico City (Juday 1915). Localities from which *E. microdontus* are known are indicated by a white dot and specifically labelled as to lake or locality. The other records are either for the species in the subgenus *Bullatifrons* or those for which the specific identification is uncertain (cf. Table 2). Most of the records from Tennessee and northern Alabama are from various T.V.A. reservoirs.

Table 1. Known occurrences of species of *Eurycercus (Eurycercus) microdontus* new species.

State	Locality	County or Parish	Date	Collection No.[1]	Number of specimens: Intact Specimens	Whole Exuviae	Head Shields	Post-abdomens	Shells
North Carolina	Pages Lake	Bladen	18-VIII-58	Sediments			21	16	3
			18-VIII-58	DGF 50			+		+
	White Lake	Bladen	27-VII-50	DGF 466	61		+		+
			19-VIII-48	DGF 468			++	+	++
	Golf Course Lake at Southern Pines	Moore	10-II-40	NMNH 81672	4				
South Carolina	Par Pond, SRP	Aiken	1-XI-73	DGF 3337			1		
			21-XI-73	DGF 3339	3				1
Georgia	Lilly Pond	Bulloch	20-IV-74	D.L. Dycus	29	3	3	1	3
	Marshlike Pond	Laurens	20-IV-74	D.L. Dycus	8		1	1	11
Florida	Lake Annie	Highlands	25-VII-60	DGF 111a			2		
			23-I-70	DGF 2918			5		4
			3-XII-72	DGF 2913-17	1	2	2		3
	Buck Lake	Highlands	9-VIII-60	DGF 173			1	1	2
			3-XII-72	DGF 2909-12	7		8		12
	Lake June in Winter	Highlands	3-VIII-60	DGF 144	9				
			3-XII-72	DGF 2905-08	70		7		13
	Lake Jackson	Highlands	12-VIII-60	DGF 181	9				2
Louisiana	Slidell	St. Tammany	31-XII-05	EAB tube Ey/1	5				
	Lake Charles	Calcasieu	27-X-03	EAB tube Ey/12	1				
	Bennett's Bay	Rapides	9-VI-60	DeCosta sediments			3		
Texas	Smithville	Bastrop	Oct. 1903	EAB slide C-55-17	1				

[1]DGF = D.G. Frey Collection in Bloomington; EAB = E.A. Birge Collection, also located in Bloomington; NMNH = National Museum of Natural History (=U.S. National Museum) in Washington, D.C. The samples from Par Pond were collected by W.M. Lewis, Jr., those from Pages Lake by Pamela Patterson. The D.L. Dycus samples from Georgia were provided by D.C. Wade. For Pages and White Lakes, + indicates present, ++ abundant.

occur together in Bennett's Bay and in Par Pond, S. C. In Par Pond only *Bullatifrons* was present – abundantly so – on 5 May 1973 and again on 30 January 1974 in much smaller numbers, and only *E. microdontus* (in very low abundance)in November 1973, suggesting a seasonal replacement of one species by the other. In other parts of the world where the ranges of two species of *Eurycercus* overlap, although any given body of water generally has only one of the species, both can occur in the same water body and at the same time. This is true, for example, of *E. lamellatus* sensu strictu and *E. glacialis* in Bislet Dam, Denmark (Kaiser 1959) and in Iceland (D. G. Frey observation in 1972) and of *E. lamellatus* and *E. pompholygodes* in several lakes in northern Sweden (Frey 1974) All two-species populations known to date involve species from different subgenera. At least in the lakes in Iceland and northern Sweden, both species of the pairs were present and reproductive at the same time, demonstrating that temporal displacement is not a requirement for occupying the same water body.

METHODS

Personal samples collected prior to 1965 were obtained with a short conical plankton net of 70 μm Nitex 15 cm in diameter mounted on a rod about 1 meter long. Subsequent samples were collected with a 110 μm mesh Nitex net of about the same size, which could be screwed into a sectional metal rod 3 meters long. The mouth of the latter net was protected by a hinged metal screen with meshes 5 mm bar measure to keep out leaves, macrophytes, and other coarse material. The entire contents were preserved in roughtly 5% commercial formalin.

In the laboratory subsamples were spread in a petri dish, systematically scanned at 15 X stereo magnification, and all specimens, exuviae, and exuvial fragments were removed as encountered, all of which were gradually transferred to glycerol for facilitating measuring and dissecting. Because of the small size of this species, all specimens were measured in temporary uncovered glycerol mounts with a Wild (M20) compound microscope using 10X eyepieces and either 3X, 10X, or 20X objectives, depending on the size of the specimen. By this procedure length of the specimen and length of the postabdomen and postabdominal claws could be measured conveniently, and the number of denticles on the postabdomen and of spinules on the postabdominal claw could be counted except in the smallest specimens. Details of the smaller exuvial components were studied in permanent mounts with 40X or 100X objectives.

In the previous studies (Frey 1973, 1974) the regressions of denticle counts on trunk limbs I and II as a function of length of the toothed zone of the postabdomen, which in turn is a function of overall size of the animal, were determined from complete exuviae recovered from the collections. In the present study virtually no intact exuviae were available, and hence these regressions had to be based on specimens sacrificed for dissection. Twelve specimens each from Lake June in Winter and White Lake, evenly distributed over the size ranges of the populations, except for the largest specimens which were too valuable for sacrifice, were used for this purpose. Dissections were made in glycerol at a magnification of 45X with a stereoscope, using tungsten needles. After removal of the head with its attached appendages and then the shell and postabdomen. the trunk limbs were separated longitudinally into right and left groups. In the smallest specimens only trunk limbs I and II were separated from their respective groups, whereas in larger specimens all trunk limbs were separated from one another. These were then mounted in polyvinyl lactophenol and eventually sealed with glyceel (available from ESBE, Toronto) for convenience in studying at whatever magnification was necessary, up to oil immersion.

All measurements and counts were punched on IBM cards for calculation of regression statistics and correlation coefficients, using the SPSS programs (Table 4). Although these simple techniques are not entirely appropriate because of the nature of the variables, they do identify which char-

Table 2. Known occurrences of the subgenus *Bullatifrons* of *Eurycercus* in the Southern United States and in Mexico. Where no specimens were available for examination, the subgenus could not be decided but it probably was *Bullatifrons*.

State	Locality	County or Parish	Date	Reference[1]	Comments	Subgenus
North Carolina	Highlands Lake	Macon	10-IV-65	DGF 1746, 2301	Very abundant (>1000)	*Bullatifrons*
	Santeetlah Lake	Graham	25-V-69	(Bunting)	1 parth. ♀, 1 ephip. ♀	*Bullatifrons*
South Carolina	Blackville	Barnwell	14-IV-65	DGF 2302	1 shell	*Bullatifrons*
	Par Pond, SRP	Aiken	5-V-73	DGF 3340-3343	Many specimens (>200) plus exuviae	*Bullatifrons*
			30-I-74	DGF 3344-3347	29 specimens plus >200 fragments	*Bullatifrons*
	Hartwell Lake	Anderson	9-I-71	(Bunting)	1 parth. ♀, 1 imm.	*Bullatifrons*
Georgia	Augusta region	Richmond	1907-1908	Turner (1910)	Abundant at 4-8°	?
	Flint River	Sumpter	22-V-69	(Bunting)	3 parth. ♀, 1 imm.	*Bullatifrons*
Florida	Newnan's Lake	Alachua	3-III-65	(Harmsworth)	1 imm.	*Bullatifrons?*
Alabama	Wheeler Res.	Limestone	2-IV-73	(Wade)	TVA: Trousdale Hollow	?
	Guntersville Res.	Jackson	13-VII-72	(Wade)	TVA: Slough above Sublet ferry	*Bullatifrons*
Mississippi	Pearl River System	Leake, Attala	10-V and 4-IV-67	Chien (1969)	3 sites; low abundance	?
			9-V-74	DGF 3413-3414	Chien's Sta. 3, 8; abundant at Sta. 3	*Bullatifrons*
	Sardis Res.	Panola	27-VIII-53	Hanebrink (1965)[2]	Only in Hurricane Bay; 48 specimens/liter	?
			7-VI-61	DeCosta sediments	2 head shields, 1 shell	*Bullatifrons*
			8-V-74	DGF 3412	1 specimen, 2 shells, 1 head shield	*Bullatifrons*
Louisiana	Horseshoe Lake	Concordia	June 1960 and 1961	DeCosta (1964)	65 exuvial fragments from sediments	*Bullatifrons* (See Table 3)
	Bennett's Bay	Rapides				
	Miller's Lake	Evangeline				
	Chicot Lake	Evangeline				
	Cazan's Lake	Evangeline				
	New Orleans Region		ca. 1905	Penn (1947)	Listed by Ed. Foster	?
	Kisatchie Natl. Forest	Grant	3-IV-72	(Becker)	2 specimens, 1 head shield	*Bullatifrons*
	Lake Charles	Calcasieu	4-IV-61	DeCosta sediments	1 head shield	*Bullatifrons*
	Courtebleau Bayou	St. Landry	10-V-74	DGF 3418	abundant: ephippial females and a few males	*Bullatifrons*

State	Locality	County or Paris	Date	References[1]	Comments	Subgenus
Tennessee	Reelfoot Lake	Obion	Early 1942	Hoff (1943)	In 3 of 214 collections	?
			4-VI-60	DeCosta (1964)	Remains from sediments	*Bullatifrons*
			11-VI-74	DGF 3426-3427	Lakeside Pond in Tenn. Natl. Wildlife Refuge: abundant; ephip. females	*Bullatifrons*
	Old Hickory Res.	Sumner	22-V-73 14-VI-73 11-II-74 4-IV-74 1-V-74	(Wade)	TVA: Gallatin Steam plant; river mile 240, 241	*Bullatifrons*
	Barkley Res.	Stewart	23-IV-74	(Wade)	TVA: river mile 104	?
	Nickajack Res.	Marion	12-XII-73	(Wade)	TVA: river mile 435	?
	Tellico Res. site	Blount	1-V-73	(Wade)	TVA: river mile 33	?
	Melton Hill Res.	Anderson	6-VIII-73	(Wade)	TVA: Bull Run Steam Plant	?
	Little Tennessee River	?	14-VI-73	(Wade)	TVA: 56 specimens	*Bullatifrons*
Arkansas	Horseshoe Lake	St. Francis	4-VI-60	DeCosta (1964)	4 remains from sediments	*Bullatifrons*
	5 mi. east of Clarendon	Monroe	30-III-59	DGF 511	Several specimens	*Bullatifrons*
Oklahoma	Entire state		Jan. 1947 – Sept. 1953	Jones (1958)[3]	Merely listed; no other information	?
Mexico	Mexico City		Feb. 1910?	Juday (1915)	Sunken Gardens and Lakeside Tivoli; no other information	?

[1]Samples DGF 2301, 2302, 3340-3343, and the specimen from Newnan's Lake, Fla., were collected by R. V. Harmsworth; Samples DGF 3344-3347 by W. M. Lewis, Jr.; Sample DGF 511 by F. N. Young; the sample from the Kisatchie National Forest, La., by P. R. Becker; and the samples from Santeetlah Lake, Hartwell Lake, S. C., and Flint River, Ga., by Dewey Bunting. D. C. Wade kindly made available his records and samples of *Eurycercus* from the TVA system of reservoirs. As specimens from most of these collections are no longer available, the subgenus cannot be decided for certain, although most likely it is *Bullatifrons*.

[2]Hanebrink (in correspondence) reported that the specimens have been lost. The taxon was collected only once.

[3]Jones reported in his paper that specimens of all taxa had been deposited in the National Museum of Natural History, but there is no record of these and hence no specimens.

[4]Since writing this paper I have been able to examine the PhD thesis of W.H. Jones from the University of Oklahoma, 1954: "Cladocera of Oklahoma." For the Chydoridae there are a disturbing number of discrepancies between Table I in the thesis and its abbreviated version in the published paper. The Thesis table indicates that Jones never collected *Eurycercus* in Oklahoma but that he *expected* it to occur. The published paper lists *Eurycercus* among the chydorids *known* to occur in Oklahoma, which is obviously incorrect.

Table 3. Reexamination of sediment samples from lakes along the lower Mississippi River collected by DeCosta (1964) in 1960 and 1961. All the head shields and shells (and hence presumably the other remains as well) were of *Eurycercus (Bullatifrons)* sp. except in Bennett's Bay, where 3 of 24 head shields were from *E. (Eurycercus) microdontus* (see Table 1).

	DeCosta's data			Remains recovered in present study			
No.	Lake and State	No. *Eurycercus*	% total chydorid remains	Head shields	Post-abdomens	Shells	Ephippia
24	Reelfoot Lake, Tenn.	4	1.9	19	6	1	
26	Horseshoe Lake, Ark.	4	1.0	46	14	11	
36	Horseshoe Lake, La.[1]	1	0.5				
37	Bennett's Bay, La.	3	1.2	24	4		
38	Miller's Lake, La.	25	6.6	47	46		2
39	Chicot Lake, La.	15	1.6	35	26	3	2
41	Cazan's Lake, La.	21	9.7	30	28	1	
—	Sardis Reservoir, Miss.	—	—	2		1	
—	Lake Charles, La.[1]	—	—	1			

[1]About 75 cc of sediment from Horseshoe Lake, La., and 100 cc from Lake Charles were processed. Hence, the taxon at these localities, if present, must be in extremely low abundance.

acters are size dependent, and they help to quantify differences between various species and populations. A product-moment correlation analysis of one set of data yielded no better insight than a simple regression analysis.

In an attempt to locate other specimens and records for this part of the continent, many individuals who had worked in this region were contacted by letter, mostly with negative results. Remains recovered from sediments may be one of the best ways of working out geographic distributions, once the species have been characterized sufficiently for their remains to be identified to species. Certainly DeCosta's (1964) sediment samples from the region of the Lower Mississippi River were invaluable in demonstrating that *Eurycercus microdontus* apparently has a smaller frequency of occurrence than *Bullatifrons* sp.

Eurycercus (Eurycercus) microdontus
new species

Type locality. Lake June in Winter, Highlands Co., Florida: approximate geographic coordinates 27.3°N and 81.4°W. The specimens were collected along the point of land close to U.S. Highway 27 at the northeast corner of the lake in SE 1/4, S25, T36S, R29E. This is where the species had been collected previously in 1960. At this locality the bottom drops off quite steeply, and the wave action can be strong. The specimens were collected chiefly around the emergent stems of cane at water depths up to 80 cm and up to 4 m offshore.

Type material. All 70 specimens collected on 3 December 1972 plus the scattered exuvial fragments recovered.

Holotype: A parthenogenetic female 1.67 mm long in alcohol has been deposited in the National Museum of Natural History, Washington, D. C., their catalog number USNM 1.51210.

Paratypes:

1. National Museum of Natural History: two reproductive females in alcohol and one mounted in glycerine jelly, catalog number USNM 151210.

2. British Museum (Nat. Hist.) London: three reproductive females, two in alcohol

(registration numbers 1974. 717-718) and one mounted in glycerine jelly (registration number 1974. 716).

3. All other specimens and exuvial fragments are in the D. G. Frey Collection in Bloomington.

Brief diagnosis. Small, seldom as large as 2 mm. Shell strongly and sharply keeled in all instars. Seen from the side, dorsal margin of head flattened or even slightly concave between compound eye and median pore. Rostrum short, not extending much beyond base of antennules. Many minute teeth on postabdomen, increasing to 140 or more in largest specimens. Anal groove broad and shallow. Middle seta on inner distal lobe of trunk limb I well developed, rather strongly and evenly curved, heavily chitinized.

Etymology. From Gr. *micro* small, and Gr. *odons, odontos* tooth. Named for the many extremely minute teeth on the postabdomen.

General comments: E. microdontus is the second described species in the subgenus *Eurycercus, E. lamellatus* sensu strictu being the first. These two species are readily separated from the other known species of the genus by the sharp dorsal keel in parthenogenetic females and males beginning immediately behind the median head pore and by the sharp notch behind the pore which interrupts the dorsal contour. Ephippial females of the subgenus *Bullatifrons* also have a keeled shell and hence might be confused with parthenogentic females of *E. microdontus,* but the keel does not involve the head. As a result the head shields even of these keeled ephippial females are rounded behind, rather than pointed as in the subgenus *Eurycercus.* Moreover, the keel of ephippial females is rounded, rather than sharp as in parthenogenetic females of the subgenus *Eurycercus,* as illustrated for *E. pompholygodes* in Frey (1974).

Although the populations from White Lake and Lake June in Winter are indistinguishable in most respects, they do differ significantly in number and shape of teeth on the postabdomen, in length of the postabdomen relative to body length, and in size at which reproduction begins. These differences and others will be pointed out where appropriate. At least for the present, the two populations are considered to belong to the same species.

Size. The sample from Lake June in Winter has a size range of 0.58-1.67 mm, with the smallest reproductive female (embryos in brood pouch) measuring 1.41 mm. The specimens from White Lake range in size from 0.58 to 1.61 mm, with individuals as small as 1.19 mm having embryos in the brood pouch. One isolated postabdomen 701 μm long from the sediments of Pages Lake corresponds to a body length of 2.02 mm, according to regression 1 in Table 4. The four specimens from Southern Pines, N. C., measured 1.75-2.23 mm, all larger than the largest specimens from Lake June in Winter and White Lake. Of the other miscellaneous specimens available, the largest was a parthenogenetic female about 1.7 mm long from Slidell, La. Hence, the species is small, seldom attaining a length as great as 2 mm.

Shape (Figs. 2-4). The shape of *E. microdontus* changes during ontogeny. The early pre-reproductive instars have the shell only weakly arched dorsally and the head relatively high (Fig. 4), resulting in an overall appearance rather similar to *E. macracanthus* although more elongate. Beginning immediately prior to maturity, the back becomes progressively more highly arched and more sharply keeled (Fig. 2), both characters being considerably more extreme than in *E. lamellatus.* The high arch to the shell can be regarded as one mechanism for increasing the brood pouch capacity and hence the reproductive potential of this small species.

In lateral contour the head is flattened or even slightly concave between the compound eye and the median pore (Figs. 2, 5). Because the rostrum is short, the compound eye is located closer to the tip of the rostrum than in *E. lamellatus,* more resembling *E. macracanthus* in this respect. The posterior margin of the shell slopes posteriorly resulting in the dorsal angle being located considerably farther forward than the ventral angle (Figs. 2, 4). This condition also tends to occur in *E. lamellatus* and *E. pompholygodes,* although not so extreme.

Table 4. Comparison of regression statistics for *E. microdontus* from Lake June in Winter (J), Florida, and White Lake (W), North Carolina, Regressions 14-19 are concerned with the denticles on scraping spines 2, 3, and 4 of trunk limb II, regressions 20-27 with the four clusters of spinules on the basal segment of the inner distal lobe of trunk limb I. All measurements are in microns, rounded off to the nearest 5 except for those made with the 40X and 100X objectives.

Variables					y			x					
Regression	Dependent (y)	Independent (x)	Locality	n	Range	Mean	Std. dev.	Range	Mean	Std. dev.	Slope	y-intercept	Correl. coeff.
1	length postabd.	length animal	W	58	205-545	349	82.5	585-1610	998	237.4	.3424	7.50	.98
2			J	68	210-660	389	124.8	585-1670	1029	306.3	.4060	−28.93	.99
3	length shell	length postabd.	W	12	590-1340	895	248.1	270-510	348	89.8	2.7396	−57.44	.99
4			J	8	540-1425	1010	313.1	225-610	429	135.5	2.3069	20.99	.99
5	length head	length postabd.	J	5	535-810	691	102.8	365-610	507	90.3	1.1373	113.92	.99
6	postabd. teeth	length postabd.	W	55	75-117	91.5	9.36	205-545	347	82.9	.0910	59.89	.80
7			J	71	83-146	108.2	20.42	215-660	386	121.1	.1563	47.91	.92
8	length claw	length postabd.	W	55	66-155	105.8	22.24	205-545	348	84.1	.2585	15.68	.97
9			J	34	71-178	130.5	29.49	225-660	477	118.8	.2434	14.49	.98
10	Claw denticles	length postabd.	W	35	26-39	32.8	4.12	205-545	370	88.9	.0425	17.09	.91
11			J	26	28-44	36.4	4.16	225-565	437	106.4	.0342	21.49	.87
12	claw denticles	length claw	W	35	26-39	32.8	4.12	66-155	111.3	22.67	.1672	14.19	.91
13			J	26	28-44	36.4	4.16	71-152	119.6	24.38	.1435	19.25	.84
14	SS2 denticles	length postabd.	W	21	12-22	18.1	2.99	270-510	352	84.5	.0308	7.30	.87
15			J	22	10-27	18.7	4.61	225-610	384	116.2	.0356	5.05	.89
16	SS3 denticles	length postabd.	W	23	13-24	18.9	3.14	270-510	343	86.8	.0330	7.56	.91
17			J	23	11-28	19.6	4.57	225-610	385	116.1	.0368	5.38	.93
18	SS4 denticles	length postabd.	W	21	15-25	19.3	3.39	270-510	340	90.3	.0225	11.64	.59
19			J	21	15-31	21.5	4.42	225-610	372	111.0	.0367	7.90	.92
20	prox. spinules	length postabd.	W	32	4-10	6.5	1.34	205-530	343	77.4	.0129	2.04	.74
21			J	27	4-11	7.0	2.17	225-610	406	121.6	.0157	.60	.87
22	dist. spinules	length postabd.	W	33	5-9	6.3	1.05	205-530	341	76.8	.0076	3.75	.55
23			J	27	4-8	5.6	1.15	225-610	394	125.8	.0076	2.62	.83
24	marg. spinules	length postabd.	W	22	3-11	6.7	2.21	210-510	335	80.6	.0231	−1.00	.84
25			J	25	1-11	5.6	2.58	225-610	403	132.4	.0173	−1.33	.88
26	basal spinules	length postabd.	W	17	2-14	7.1	3.58	270-455	347	63.4	.0488	−9.91	.86
27			J	14	3-14	9.1	3.34	300-610	459	108.2	.0233	−1.61	.75
28	head L/W ratio	head length	All	70	.97-1.18	1.031	.0484	410-1180	548	130.5	−.00019	1.15	.50

Head (Figs. 6-17). All appendages and the labrum were removed from head shields before mounting to get them to lie flat. This was also done for *E. pompholygodes* (Frey 1974) but not for the three species treated earlier (Frey 1973), which helps explain the seemingly greater variability in shape of these other three species. The convexity of the head shields varies considerably from one species to another, so that even with these precautions in preparation it is still difficult at times to get preparations satisfactory for characterizing the shape and for making length and width measurements. The relatively flat head shields of *E. microdontus, E. pompholygodes,* and *E. macracanthus* can be mounted with less distortion than the more convex head shields of the other two larger species.

The head shield is about as broad as long, the rostrum is short, not projecting much beyond the base of the antennules, and the transverse fold behind the median pore is much more deeply incised than in *E. lamellatus.* As a result, the median pore is visible with difficulty on mounted head shields, sometimes not being visible at all, at other times with only a small bit of the pore projecting anteriorly or posteriorly from the fold. The lateral pores occur at the ends of the transverse fold, which frequently obscures them and makes them difficult to see. The material at hand (or perhaps the species) was not suitable for working out size-dependent regressions of pore width and distance between lateral pores, as in *E. pompholygodes.*

The chitinous border of the free edge of the head shield is thickened somewhat anterior to the mandibular articulation, which seems to be characteristic of this species. The keel begins immediately behind the median pore, which results in a triangular extension of the head shield posteriorly, as in *E. lamellatus,* although more pronounced because of the higher and sharper keel. The ocellus is small, generally quadrate in appearance, and located near the anterior edge of the base of the antennules.

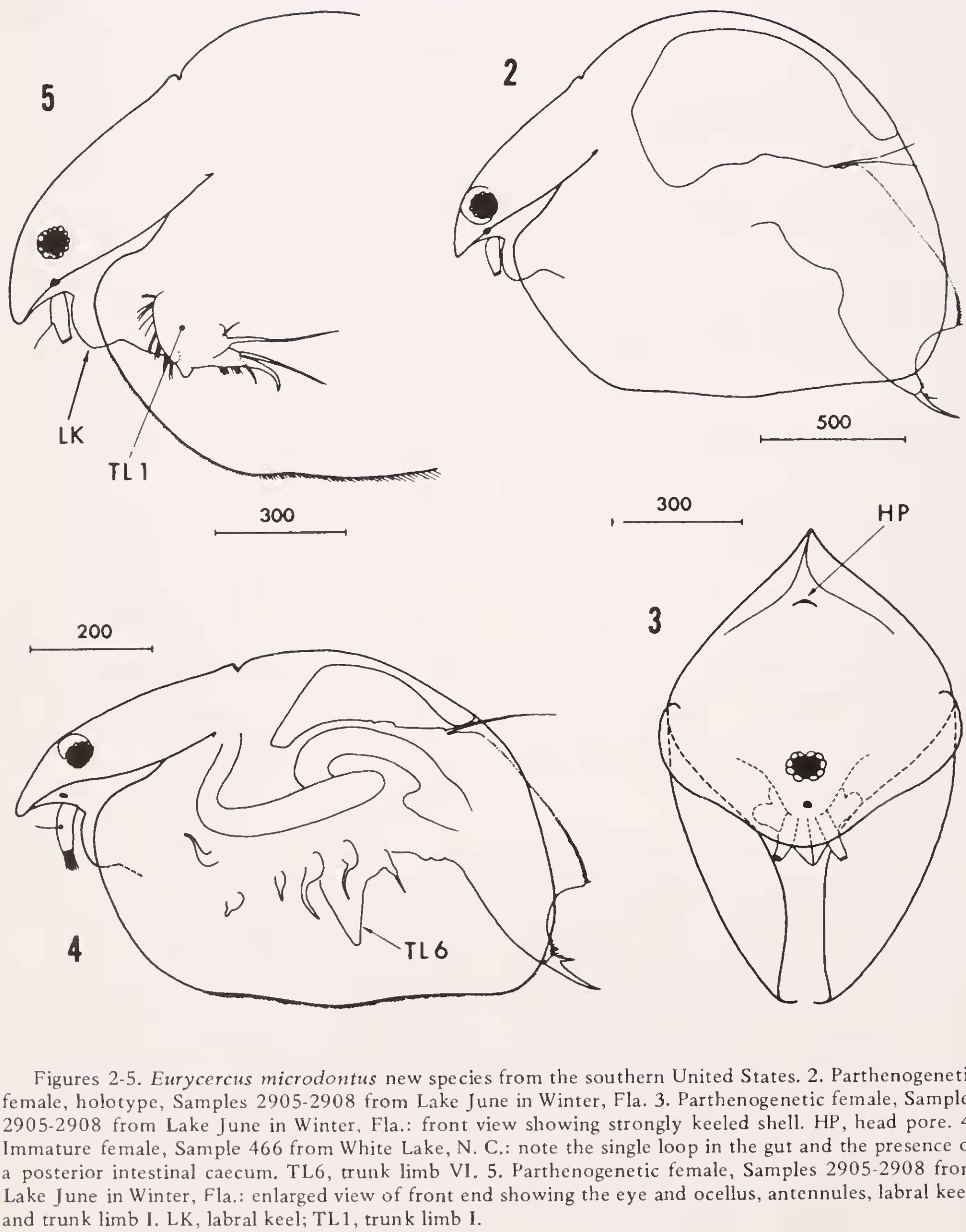
There are no obvious or consistent differences between the head shields of the Florida and North Carolina populations, or the three head shields from Bennett's Bay, La. A head shield of *Bullatifrons* from the latter locality (Fig. 18) has been included for comparison. Figure 19 demonstrates that there is a distinct tendency for the length/width ratio of the head shield to decrease in larger specimens, meaning that as the animals increase in size, the head shield becomes progressively broader relative to its length. Because no head shields from small Florida specimens were available, the White Lake and Florida populations could not be compared statistically, although the scattergram suggests no appreciable differences in the relationship.

Labrum (Figs. 2-5). The labral keel is about intermediate in development between *E. pompholygodes* and *E. lamellatus,* not angled posteriorly as in *E. lamellatus.*

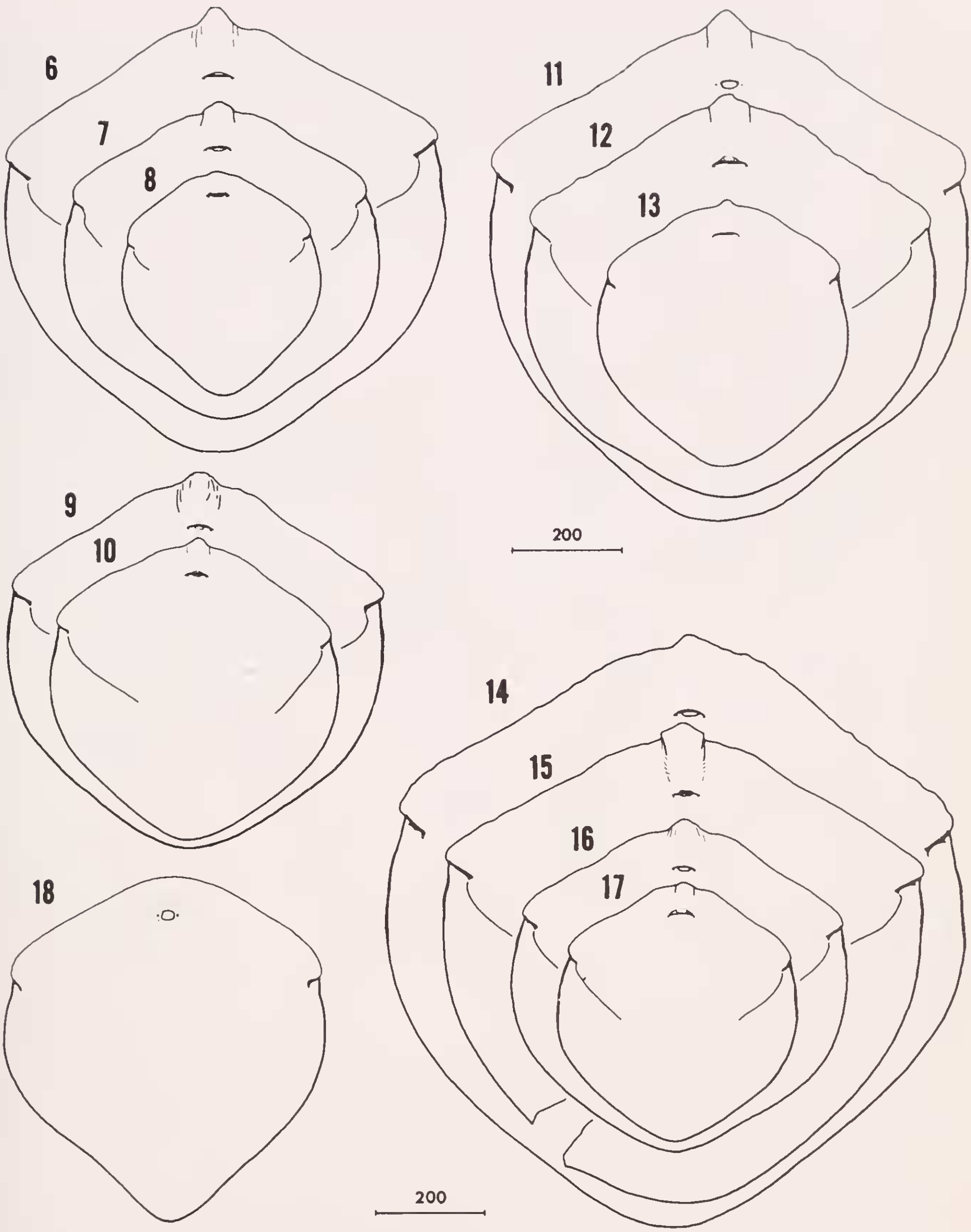
Antennule (Figs. 2-5, 30). The specimen drawn (Fig. 30) is good for general shape and proportions. The lateral seta arises from about the middle and is more than half as long as the antennule. The terminal setae could not be resolved in the specimen drawn, but in some other specimens there were definitely nine, subequal in length.

Antenna (Fig. 31). The antenna likewise seems relatively undifferentiated at the species level. It shares the common pattern of eight long and well developed swimming setae, three spines on the outer branch, and one on the inner branch (cf. Fig. 26 for *macracanthus* in Frey 1973). The various species may possibly be differentiated in the number and length of spinules on the rounded protuberance near the base of the antenna, or in the morphology of the two long 2-jointed setae nearby, but these characters have not yet been investigated.

Trunk limb I (Figs. 5, 20, 21). The morphology of trunk limb I is quite similar in all species studied to date (Frey 1973, 1974), the major differences at the species level occurring in the structure of the inner distal lobe (IDL). The three clasping hooks (Fryer's 1963 terminology) on this limb in *microdontus* are quite similar in shape and armament to those of *pompholygodes,* even though in a different subgenus, the chief differences being 1) the setules on clasping hook 1 do not extend so far toward the tip, being more like *E. lamellatus* in this respect, and 2) clasping hook 2 is more strongly curved than in *E. pompholygodes* and much more strongly chitinized and hook-like than in *E. lamellatus*. As in *E. pompholygodes* and to a much less extent in *E. lamellatus*, clasping hook 2 seems to have a cutting edge distally (Fig. 21). Midway along this seta on its concave surface is a series of 6-8 setules that are quite discrete and can be made out quite clearly, with suggestions of other smaller setules distal to these. Only the tips



Figures 2-5. *Eurycercus microdontus* new species from the southern United States. 2. Parthenogenetic female, holotype, Samples 2905-2908 from Lake June in Winter, Fla. 3. Parthenogenetic female, Samples 2905-2908 from Lake June in Winter, Fla.: front view showing strongly keeled shell. HP, head pore. 4. Immature female, Sample 466 from White Lake, N. C.: note the single loop in the gut and the presence of a posterior intestinal caecum. TL6, trunk limb VI. 5. Parthenogenetic female, Samples 2905-2908 from Lake June in Winter, Fla.: enlarged view of front end showing the eye and ocellus, antennules, labral keel, and trunk limb I. LK, labral keel; TL1, trunk limb I.



Figures 6-18. *Eurycercus microdontus* new species (Figs. 6-17) from the southern United States. The head shields are mainly from detritus in the samples or from sediments. Only the few from exuviae could be related to length of postabdomen. The head appendages and labrum were removed before mounting to give the least possible distortion in shape. 6. Lake June in Winter, Fla., Samples 2905-2908. Length of postabdomen 610 μm. 7. White Lake, N. C., Sample 468. 8. Pages Lake, N. C., sediments. 9. Lake Annie, Fla., Samples 2913-2917. Length of postabdomen 515 μm. 10. Lake June in Winter, Fla., Samples 2905-2908. 11. Bennett's Bay, La., sediments. 12. White Lake, N. C., Sample 468. 13. White Lake, N. C., Sample 468. 14. Pages Lake, N. C., sediments. 15. Lake June in Winter, Fla., Samples 2905-2908. 16. Lake June in Winter, Fla., Samples 2905-2908. 17. White Lake, N. C., Sample 468. 18. *Eurycercus (Bullatifrons)* sp. from sediments of Bennett's Bay, La., to show the contrast in head shield morphology. This is the more common species in the region.

of the latter are apparent, their bases seeming to have fused together to form the proximal part of the cutting edge, as in *E. pompholygodes.* The two segments of clasping hook 2 are immovably fused together, as in all other species studied to date, and the basal segment of the hook seems to be immovably fused with the basal segment of the lobe. The latter condition is also true in *E. macracanthus* and *E. pompholygodes,* less certainly true in *E. lamellatus,* and possibly not true in *E. glacialis.* In all species clasping hooks 1 and 3 are articulated with the basal segment of the lobe, permitting movement relative to one another.

The basal segment bears the three clusters of spinules described in *E. pompholygodes* – designated proximal, distal, and marginal spinules – and in addition an irregular cluster of extremely small spinules – here designated basal spinules – lying in the general vicinity of the proximal spinules (Fig. 21). The number of spinules in each group increases significantly with size of specimen and all at about the same rate. Differences between slope and displacement of the regressions for the Florida and North Carolina populations are not significant, as the 95% confidence limits of the regressions overlap completely. More specimens are needed, and particularly at the upper end of the size distributions, to define these regressions more precisely. Certainly the proximal and distal clusters are more suitable for characterizing the species, the other two groups exhibiting greater variances and much broader confidence intervals. The rate of increase in each group (except basal, which was not studied) is greater in *E. microdontus* than in *E. pompholygodes.* Regressions have

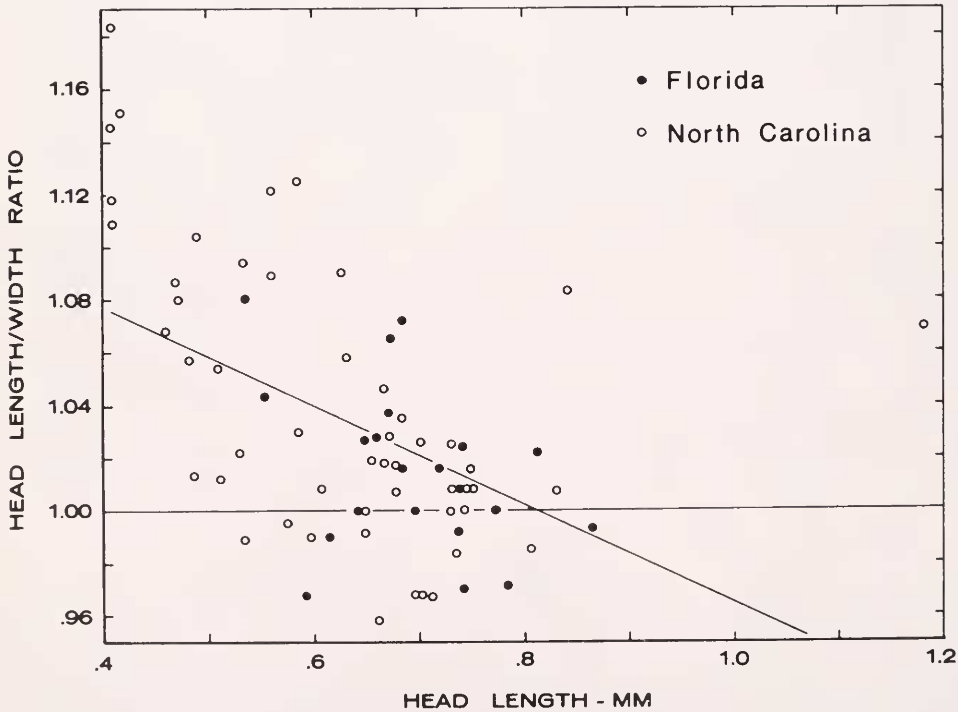
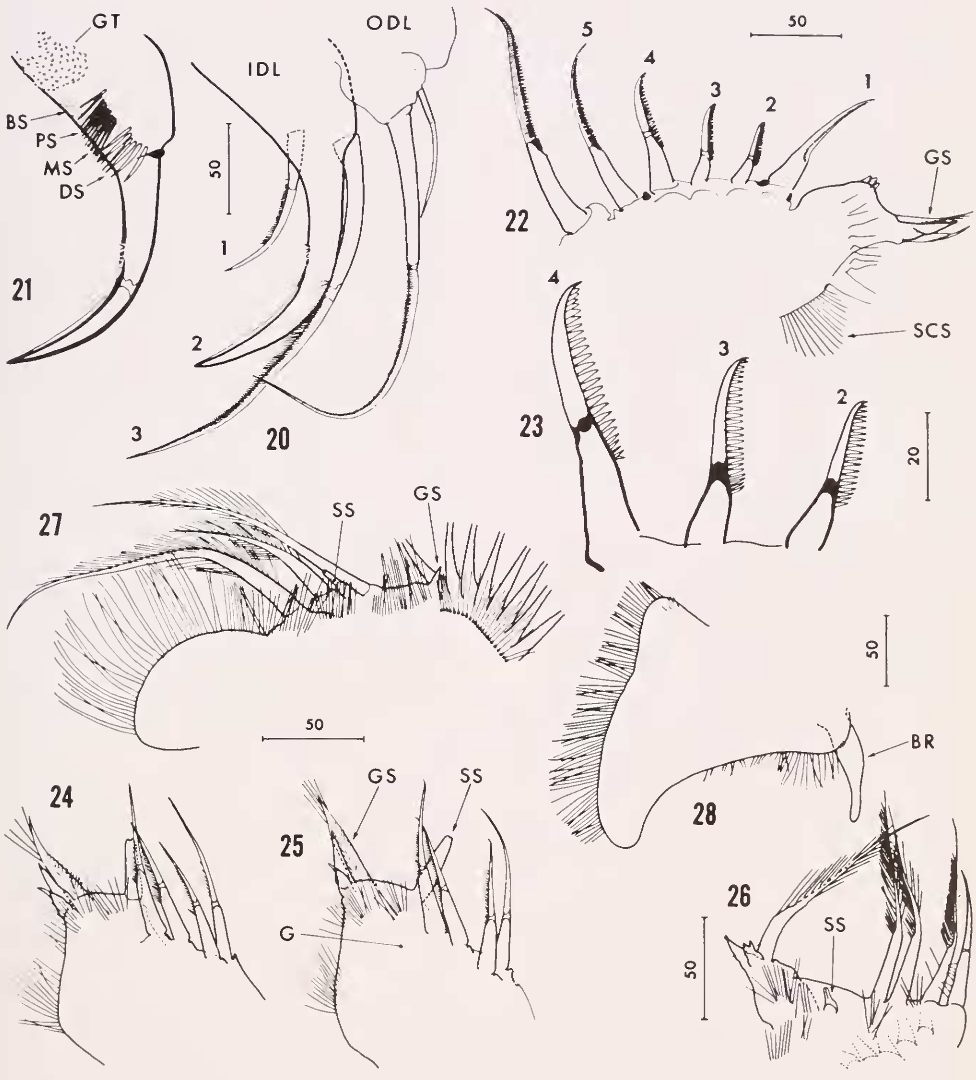


Figure 19. Scattergram and least-squares regression for length/width ratio of the head shield versus the length of the head shield. Florida specimens are from Lake June in Winter, Buck Lake, and Lake Annie. North Carolina specimens are from White Lake and Pages Lake. The regression statistics are given in Table 4.



Figures 20-28. *Eurycercus microdontus* new species from the southern United States. Only those portions of the first five trunk limbs containing potentially diagnostic details have been included. The remaining portions of the trunk limbs seem indistinguishable from those of *E. macracanthus,* fully illustrated in Frey (1973). Figs. 20-23 and 25-27 are drawn from an intact exuvia from Lake Annie, Fla., Samples 2913-2917 – one of the very few recovered in this study. Figs. 24 and 28 are from dissected specimens from White Lake, N. C., Sample 466. 20. Trunk limb I. IDL, inner distal lobe, ODL, outer distal lobe; 1, 2, 3, clasping hooks. 21. Clasping hook 2 of same specimen. GT, grinding tubercles; BS, basal spinules; PS, proximal spinules; MS, marginal spinules; DS, distal spinules. 22. Trunk limb II: gnathobase and adjacent scraping spines. GS, apical gnathobasic setae; SCS, screening setules; 1, 2, 3, 4, scraping spines. 23. Scraping spines 2, 3, and 4 of same specimen. 24. Trunk limb III: gnathobase and adjacent setae. 25. Trunk limb III: gnathobase and adjacent setae. GS, apical gnathobasic setae; SS, sensilla. 26. Trunk limb IV: gnathobase and adjacent setae. SS, sensilla. 27. Trunk limb V: gnathobase and adjacent setae. SS, sensilla; GS, apical gnathobasic setae. 28. Trunk limb VI. BR, respiratory bract.

not yet been worked out for the other three species.

Because the marginal and basal groups of spinules were noticed after the first study (Frey 1973), the four species previously studied were reexamined for these. *E. pompholygodes* and *E. macracanthus* regularly have the marginal spinules, but they have basal spinules mainly in the largest specimens, and even then very few. *E. lamellatus* has marginal spinules irregularly, chiefly in the larger specimens, and basal spinules even less consistently. *E. glacialis* almost never has marginal spinules. Basal spinules are generally absent in small specimens of *E. glacialis* but often abundant in a compact cluster beneath the proximal spinules in large specimens, where they are better developed than in any of the other species. Hence, the inconsistent occurrence and greater variability in number of the marginal and basal spinules suggest that they will be less useful in helping characterize species than the proximal and distal spinules.

Trunk limb II (Figs. 22, 23, 29). Again, the general configuration of this limb is about the same in all species, the chief differences being in scraping spines 2, 3, and 4, and to a lesser extent in the morphology of the gnathobase. In species of the subgenera *Eurycercus* and *Bullatifrons,* spine 2 is the shortest, then spine 3. In *E. microdontus* 4 is distinctly shorter than 1, whereas in *E. lamellatus* and *E. macracanthus* 1 is slightly shorter than 4, and in *E. pompholygodes* 1 and 4 are subequal in length. Hence, any differences in relative length of these scraping spines are species characters rather than subgeneric characters. In *E. glacialis,* by contrast, scraping spines 1, 2, and 3 are all subequal in length, and all are considerably shorter than 4.

The denticles on spines 2, 3, and 4 of *E. microdontus* are long, slender, and not contiguous at their bases, presenting more the appearance of a comb than in any of the other species studied to date (Fig. 23). The number of denticles on all three spines increases steadily with increasing size of animal and all at about the same rate. Differences between the Florida and North Carolina populations are not significant because of a virtual congruence of the 95% confidence limits of the regressions. The most important feature is that in *E. microdontus* the number of denticles on each spine is strongly size dependent, whereas in *E. pompholygodes* the number of denticles on spines 2 and 3 do not change at all with size, and spine 4 even exhibits a slight but significant decrease in denticle number with increasing size of animal (Fig. 29). Regretfully, regressions have not yet been established for *E. lamellatus* and *E. macracanthus,* and hence it is not known if these differences in regression of tooth number versus size are characteristic of species or subgenera.

The slight differences in length and structure of the three setae at the apex of the gnathobase are vague and not yet resolved on any useable basis. Their details are frequently obscured by the setae of the gnathobasic filtering plate. In the crescent of blunt pyramidal denticles on the edge of the gnathobase toward the scraping spines, the denticle that is considerably larger than the others in *E. macracanthus* and *E. pompholygodes* is scarcely larger than the others in *E. microdontus.*

Trunk limb III (Figs. 24, 25). Of the articulated setae adjacent to the gnathobase, 2 and 3, counting from the gnathobase, are considerably shorter than 1 and 4 in both the Florida and North Carolina populations. In *E. pompholygodes* and *E. macracanthus* also the middle setae are shorter than the lateral ones, but not nearly to the extent as in *E. microdontus.* In *E. lamellatus* and *E. glacialis* setae 1 and 2 are longer than 3 and 4. Otherwise trunk limb III is relatively undifferentiated at the species level. The setation on the gnathobase seems less well developed in *E. microdontus* than in the other species, which may be related to its smaller size.

Trunk limb IV (Fig. 26). There are no obvious differences in *E. microdontus* from the other species studied. The sensilla is possibly a little smaller relatively, and the two shorter setae at the tip of the gnathobase seem a little different in structure. However, the latter differences are difficult to resolve in any meaningful manner.

Trunk limb V (Fig. 27). The middle seta of the three near the sensilla is markedly shorter than the lateral ones, as in *E. macracanthus* and *E. pompholygodes.* Since the latter species are in a different subgenus than *E. microdontus,* the relative length of these setae represents specific rather than subgeneric differentiation. In the specimen drawn, only one gnathobasic seta was visible. Among the largest specimens dissected, generally two gnathobasic setae could be made out, sometimes only one, never three. Because of the difficulty in resolving such small details on dissected limbs, it is not certain that any of the limbs had only one seta. Fresh exuviae are necessary to decide this.

Both the Florida and North Carolina populations always had 8 "soft" setae and 9 gnathobasic setae on trunk limbs III and IV, and 7 and 8, respectively, on trunk limb V (Table 5). This is the general pattern in all known species of the subgenera *Eurycercus* and *Bullatifrons,* but all species except *E. microdontus* – particularly *E. pompholygodes,* for which available data are most extensive – exhibit some variability in these numbers from specimen to specimen and even between right and left limbs of the same specimen.

Trunk limb VI (Figs. 4, 28). This limb seems unusually large in *E. microdontus,* compared with the other species. It consists of an expanded triangular plate attenuated and narrowly rounded ventrally, and a respiratory bract attached posteriorly at the base. The anterior edge of the plate is provided with a double row of long setae (only one row is shown in Fig. 28) along its entire length except at the ventral tip. The proximal half of the posterior margin is provided with a single row of more widely spaced setae, which increase in length proximally toward the respiratory bract. The shape shown in Figure 4 of the whole specimen is more representative than that of the isolated limb in Figure 28, which was somewhat distorted by dissection and mounting. Both the

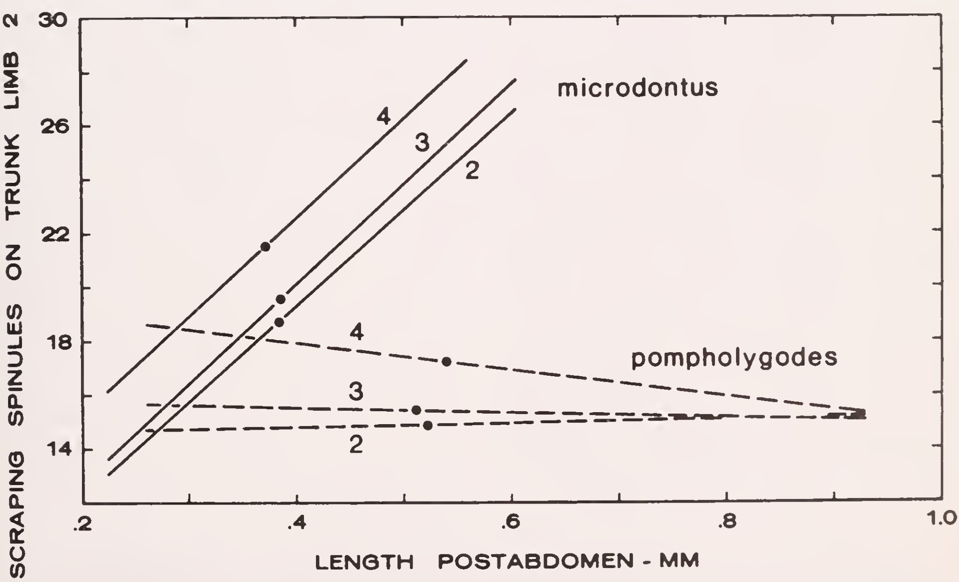
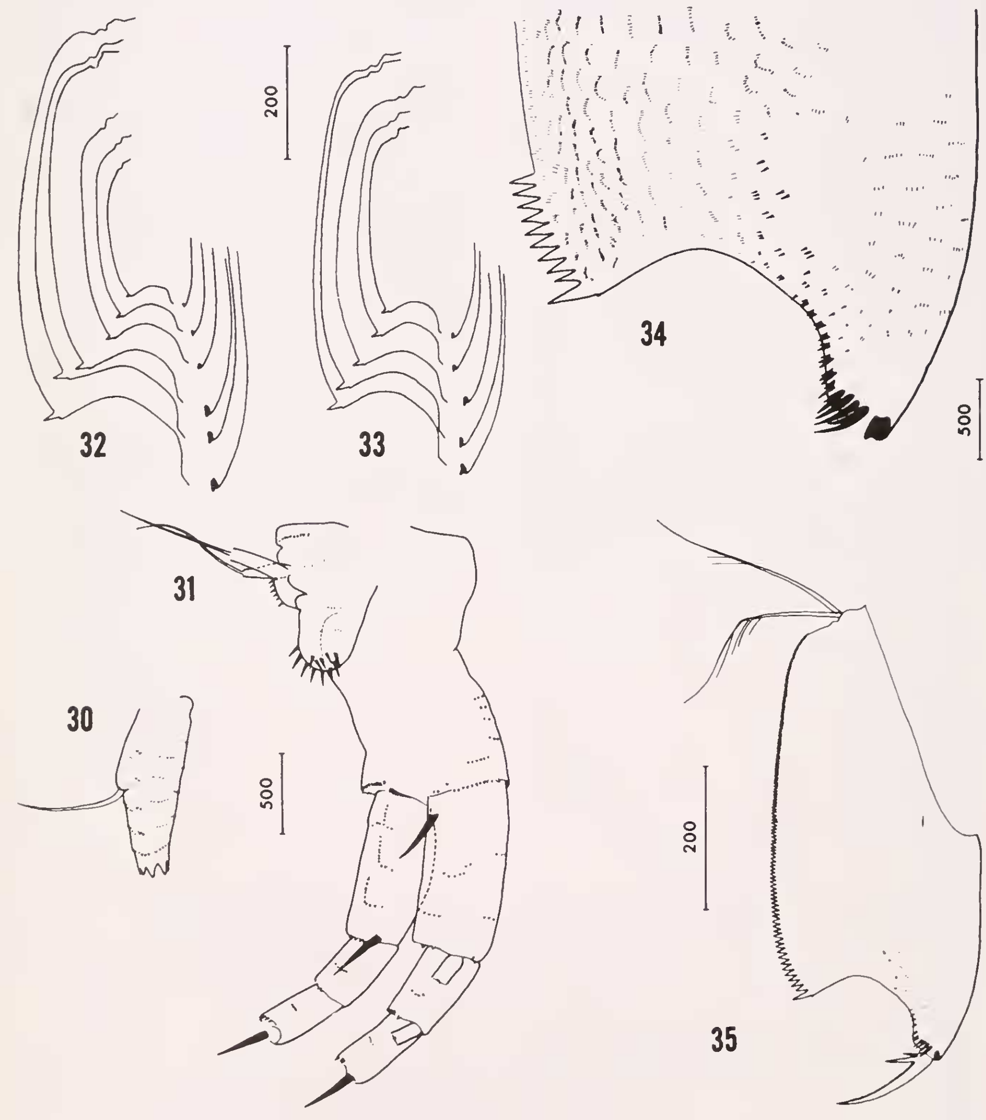


Figure 29. Least squares regressions of the number of denticles on scraping spines 2, 3, and 4 of trunk limb I versus length of postabdomen for the combined populations from White Lake and Lake June in Winter. For each regression line, the dot represents the mean of the two variables, and the length of the line corresponds to the range in length of the postabdomens. *E. pompholygodes* is a species in the subgenus *Bullatifrons* from northern Sweden (Frey 1974). These are the only two species for which these regressions have been worked out. See Table 4 for the regression statistics for *E. microdontus* for the individual localities.

Florida and North Carolina populations have the same shape and general morphology. Some of the smaller White Lake specimens, such as the one drawn (Fig. 4), were striking in the clarity with which trunk limb VI was visible, hanging vertically like a curtain on either side of the midline between trunk limbs V.



Figures 30-35. *Eurycercus microdontus* new species from the southern United States. 30. Antennule from Lake Annie, Fla., Samples 2913-2917. 31. Antenna from Lake Annie, Fla., Samples 2913-2917. The swimming setae are not shown. 32. Outline drawings of isolated postabdomens from North Carolina. Only the distalmost tooth is shown. The three largest specimens are from Pages Lake, the three smallest from White Lake. 33. Outline drawings of isolated postabdomens from Florida. The middle specimen is from Lake Annie, the other four from Lake June in Winter. 34. Distal end of postabdomen, Lake June in Winter, Fla. Note the shallow anal embayment, the truncation of the toothed zone, and the stout spines distally as well as along the mid-lateral surface. 35. Postabdomen and claw from exuvia from Lake Annie, Fla.

Table 5. Frequency of "soft" and gnathobasic setae on trunk limbs III, IV, and V of *E. microdontus*. The numbers are based mainly on dissected specimens and include both the right and left limbs of the same specimen where possible.

		Number of setae					
		Florida			N. Carolina		
Limb No.	Kind of setae	7	8	9	7	8	9
III	Soft		15			17	
	Gnathobasic			19			17
IV	Soft		20			19	
	Gnathobasic			20			14
V	Soft	16			18		
	Gnathobasic		19			17	

Postabdomen (Figs. 2, 4, 32-38). The most distinctive characters of *E. microdontus* are the large number of very minute teeth along the dorsal edge of the postabdomen and the very steep rate of increase in number of these teeth as the specimens become larger. Whereas in other morphological characters there are no significant differences between the Florida and North Carolina populations, the regressions for length of the postabdomen (Fig. 36) and number of postabdominal teeth (Fig. 37) as functions of size are statistically different. The meaning of these differences between the two populations cannot be interpreted at present. If subsequent studies suggest the desirability of separate taxonomic recognition of the two populations, then the characters of the Florida population will have to be regarded as those of the species *Eurycercus microdontus* sensu strictu.

The rate of increase in tooth number with size of animal is much greater than in any other species of *Eurycercus* studied to date, resulting in numbers greater than 140 in the largest specimens from Florida. This is the first species known in which the relationship between tooth number and size obviously is not linear but sigmoid. No attempt was made to fit higher order equations to the data, but rather lines were drawn freehand to show the general relationship (Fig. 37).

During the pre-reproductive instars tooth number increases very slowly if at all. During the early reproductive instars tooth number increases precipitously – as many as 34 teeth in a single instar – and in the later reproductive instars the rate of increase levels off once again. For those specimens in which the number of teeth in the next instar could be counted, the increase (or decrease in a few instances) in tooth number has been plotted against the length of the postabdomen in the current instar (Fig. 38). Also given are the linear regression lines of tooth number versus length of postabdomen for the populations from Lake June in Winter, White Lake, and Pages Lake. The data establish the mechanism for the production of a sigmoid relationship, namely a much greater increase in tooth number per instar during the intermediate instars. Figure 38 also demonstrates that there is no significant difference in rate of increase between the neighboring populations from White Lake and Pages Lake.

The shape of the postabdominal teeth likewise is different between the two populations. In North Carolina specimens the teeth are more triangular and saw-tooth in appearance, whereas in Florida specimens they are elongate, relatively straight-sided, and closely packed together.

The shape of the postabdomen is more variable for this species than for any of the other four species studied to date (Frey 1973, 1974). Sometimes the dorsal margin is flattened as in *E. glacialis*, at other times with a major curvature distally as in *E. macracanthus*. The anal groove is broader and shallower than in any of the other four species. The toothed zone is abruptly truncate distally, as is characteristic of the subgenera *Eurycercus* and *Bullatifrons*.

Postabdominal claw (Fig. 35). The gross morphology of the claw is quite similar in all species of *Eurycercus*. As in the other four species studied previously (Frey 1973, 1974), the number of denticles on the postabdominal claw of *E. microdontus* increases with length of the postabdominal claw and hence with size of animal. The number of denticles is less for a given claw length than in the other four species over the size range represented, but the rate of increase is as great as in *E. glacialis* and considerably greater than in the other three species. Seemingly slight differences in relative proportions of the claw, curvature, and length and stoutness of the two basal spines cannot be quantified at present.

Intestine (Fig. 4). As in all other known species of the subgenera *Eurycercus* and *Bullatifrons*, the intestine has a single loop and a well-defined caecum near the base of the postabdomen.

BIOLOGY

a) *Growth, maturity, and instar analysis*

The samples from White Lake and Lake June in Winter are not large enough for the kind of instar analysis accomplished in previous studies (Frey 1973, 1974) Even when the data are combined into size classes of 2 scale-units, the size-frequency distributions are discontinuous, and the sub-divisions may not correspond precisely to the individual pre-reproductive instars (Fig. 39).

Instar I is reasonably distinct, as in all populations of *Eurycercus* studied to date. Fifteen specimens had a size range of .58-.68 mm, with a mean of roughly .63 mm. What seems to be instar II (Fig. 39) has a size range of .75-.90 mm, with a mean of .83 mm for 41 specimens. This gives a growth ratio (.83/.63) of 1.29, which is larger than for any other species of *Eurycercus* studied to date except *E. glacialis* (Frey 1973). The two populations analyzed separately give growth ratios of 1.31 for Lake June in Winter (mean length .82 mm in Instar II for 21 specimens) and 1.27 for White Lake (mean length .79 mm for 20 specimens). The other isolated parts of the length-frequency distribution, assuming that they represent individual instars, yield similar high growth ratios compared with the other species.

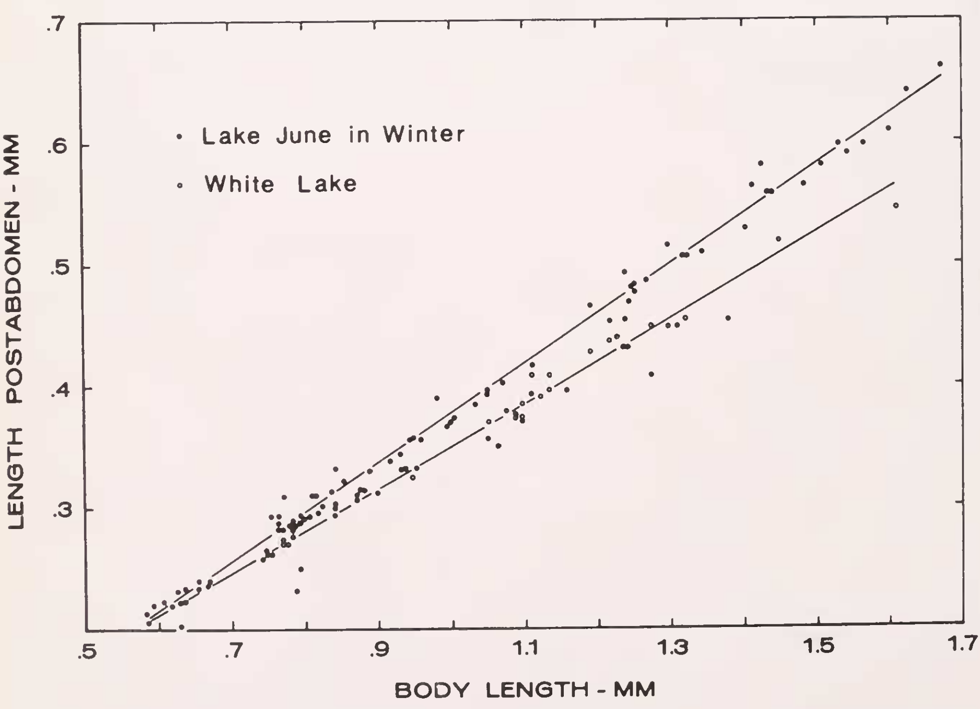


Figure 36. Scattergrams and least-squares regressions between length of postabdomen and length of animal for *E. microdontus*. Regression statistics are given in Table 4. The regressions for Lake June in Winter and White Lake are significantly different.

Either *E. microdontus* actually has fewer pre-productive instars (seemingly only three in White Lake and four in Lake June in Winter) than the other species, including the equally small species *E. macracanthus*, or else the data are misleading because of the vagaries of small sample size. However, these small numbers of pre-reproductive instars are not unreasonable, because Bottrell (1975) has found that for Cladocera in general, the number of pre-reproductive instars increases with size of species. My interpretation of the various species of *Eurycercus* parallels his findings quite closely (see below).

Previous studies have shown that 1 1/2 to 2 instars are required for the ovaries to develop to reproductive capacity (Frey 1973, 1974). The specimens from White Lake were so heavily pigmented from the filamentous algae in the collection that the stage of development of the ovaries could not be determined. For Lake June in Winter, specimens in the first two instars, as interpreted in Figure 39, either had the ovaries not visible at all, or the oocytes were extremely small. In instar III only a couple of the largest specimens had oocytes visible at the magnification used, whereas in instar IV most specimens in the latter half of their molt cycle had enlarged oocytes surrounded by yolk material, indicating that they would have become reproductive after the next molt, which is in fact what was happening on a population basis. The number of pre-productive instars in other species of *Eurycercus* increases from 5 in *E. macracanthus* and *E. pompholygodes* to 6 in *E. lamellatus* to possibly 7 in *E. glacialis*, cor-

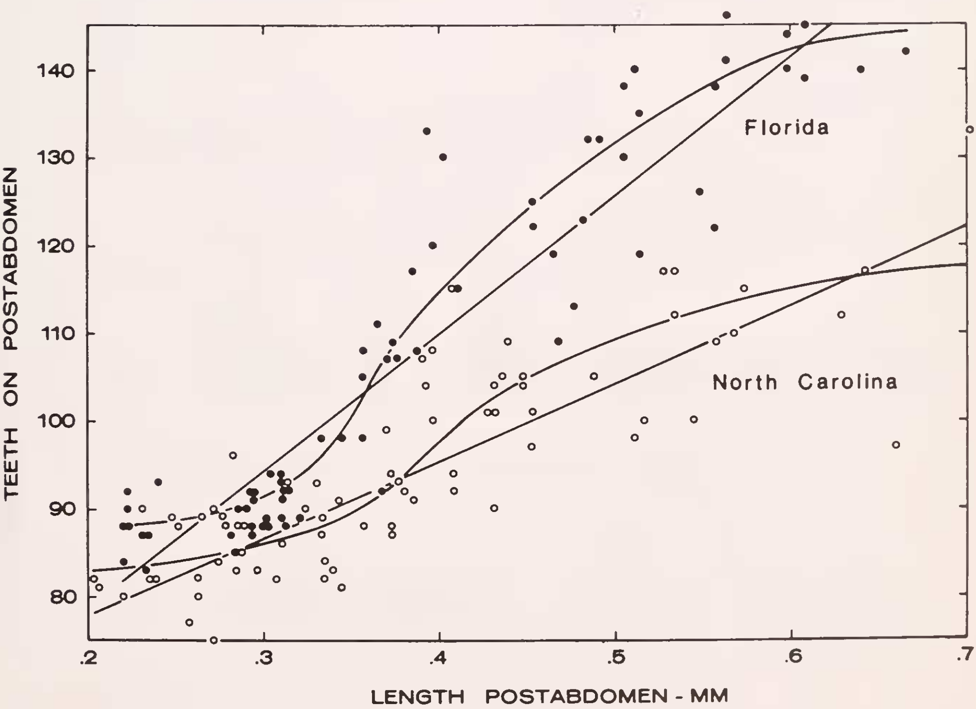


Figure 37. Scattergrams and least-squares regressions between number of postabdominal teeth and length of the postabdomen for *E. microdontus* from Florida (Lake June in Winter) and North Carolina (White Lake and Pages Lake). The relationship obviously is not linear, as shown by the poor fit of the regression lines to the data. The sigmoid curves have been drawn in freehand to suggest a more likely relationship. Even on a linear basis, the populations from Florida and North Carolina are significantly different.

responding to an increase in size at which reproduction begins. It seems rather unlikely from this size relationship that the Lake June in Winter population would have only 4 pre-reproductive instars. Nevertheless, it is definite from the data at hand that the White Lake specimens begin reproduction at a size corresponding to the last pre-reproductive instar in the population from Lake June in Winter, and hence there is a distinct possibility that they have one fewer pre-reproductive instar. Certainly, the White Lake specimens become reproductive at a smaller size than any other known population of *Eurycercus*. As is typical of the small species of *Eurycercus*, all specimens larger than the size at which parthenogenetic reproduction begins are reproductive. There is essentially no overlap in size distribution of the last pre-reproductive instar and the first reproductive instar, as there is in *E. lamellatus* and *E. glacialis* (Frey 1973).

b) *Egg size and fecundity*

The average lengths (mean ± standard deviation) of the major and minor axes of 7 recently released parthenogenetic eggs from a total of 3 individuals in the Lake June in Winter sample are 218 ± 11.7 μm and 183 ± 8.9 μm, respectively, with an axis ratio of 1.19 and an approximate mean volume of 3.8 x $10^6 \mu m^3$. Hence. the egg volume is almost identical to that of *E. macracanthus* — the next smallest species of *Eurycercus* — although the axis ratio is considerably smaller, meaning that the eggs are relatively less elongate.

For 16 parthenogenetic females 1.19-1.67 mm long with closed brood pouches, the regression of egg number against body length

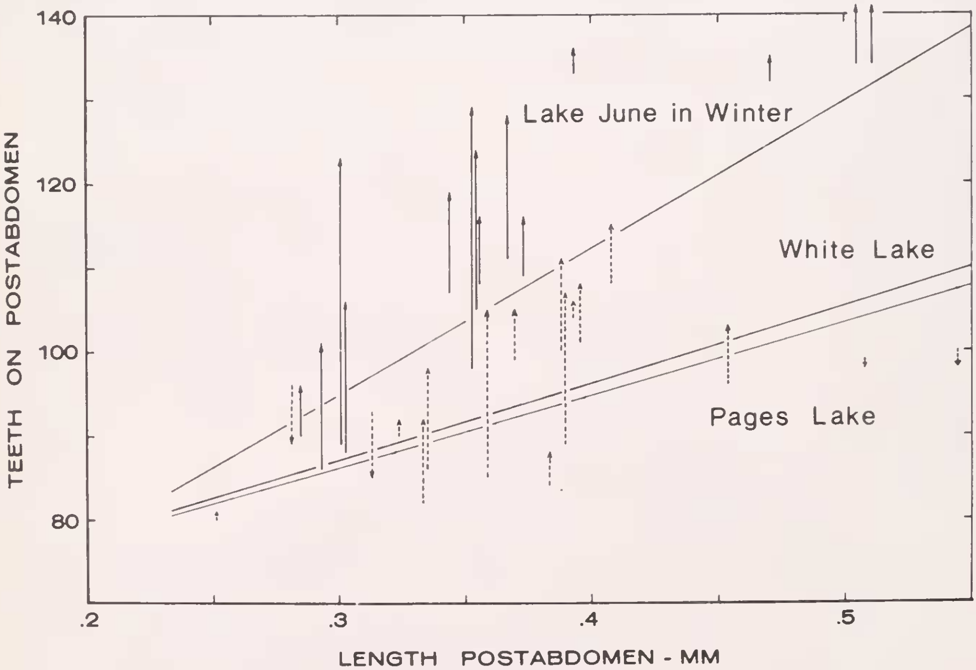


Figure 38. Increase (or decrease) in postabdominal tooth number of single specimens from the present instar to the next instar, plotted against length of postabdomen in the present instar. In both the Florida and North Carolina populations the biggest increase in tooth number tends to occur in the early reproductive instars. Also included for orientation are the least-squares regressions for the two populations from North Carolina (which do not differ from each other) and for the one from Florida (which is significantly different from the other two).

has a slope of .1899, a y-intercept of −21.51, and a correlation coefficient of .90. Included are 7 specimens from White Lake, 6 from Lake June in Winter, 2 from Lake Jackson, and 1 from Buck Lake. The specimens from White Lake all measured 1.31 mm or smaller, those from the other localities 1.34 mm or larger. Nevertheless, the scattergram indicates only a single relationship between fecundity and body length. What this suggests is that primiparous specimens from Lake June in Winter by virtue of being larger in size than the White Lake specimens at the onset of reproduction have larger broods consonant with their size. An anomalous record not included in the regression is a female 2.23 mm long from Southern Pines, N. C., which contained only 11 embryos, whereas according to the regression equation there should have been about 20.

This is a steep rate of increase in reproductive potential, which is almost identical in slope and displacement to that of the *E. macracanthus* population from Siberia. The latter, in the subgenus *Bullatifrons,* has a broadly rounded shell, which is only moderately arched dorsally over the brood pouch (cf. Fig. 1 in Frey 1973 and Figs. 1, 3, and 4 in Frey 1974). In *E. microdontus,* on the other hand, the brood pouch is compressed laterally by the development of the sharp dorsal keel (Fig. 3), but this is compensated for by the high arching of the shell over the brood pouch, resulting in the brood pouch capacity of the two species being almost the same in spite of their vastly different morphology.

As is true of all other parthenogenetic populations of *Eurycercus* studied to date except *E. glacialis* (Frey 1973, 1974), the great majority of individuals in a collection

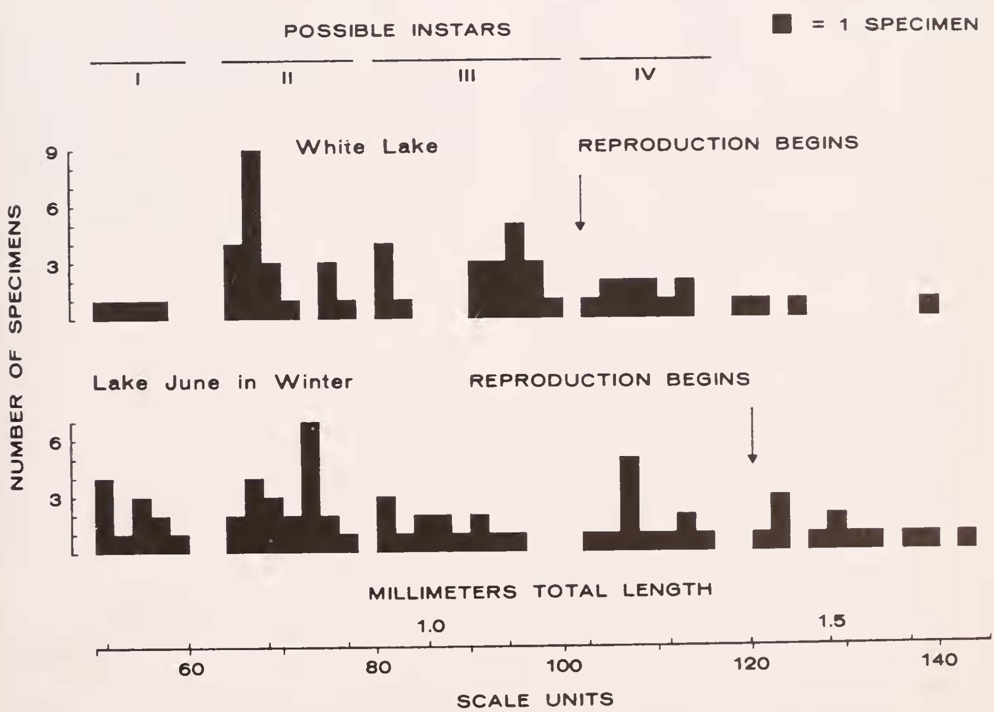


Figure 39. Length-frequency distributions of the major samples of *E. microdontus* from White Lake, N. C., and Lake June in Winter, Fla. The data have been combined into classes of 2 scale units because of the small number of specimens.

are pre-reproductive. Of the 208 intact specimens of *E. microdontus* from 12 localities (Table 3), only 28 had eggs or embryos in their brood pouches, 17 with closed brood pouches. Reproduction in this species, or at least in the White Lake population, begins at a smaller size than in any other known species of *Eurycercus*. The smallest reproductive specimen measured 1.19 mm, and 5 other specimens were less than 1.3 mm long, which is the smallest size previously known at the onset of reproduction, in the Siberian species *E. macracanthus* (Frey 1973). Other sizes at onset of reproduction are 1.34 mm in Buck Lake, 1.39 mm in Lake Jackson, and 1.41 mm in Lake June in Winter.

c) *Gamogenesis*

Males and ephippial females of this species are unknown. All individuals collected in Florida in December 1972 were parthenogenetic, even though virtually all species of chydorids in northern Indiana had been gamogenetic for some weeks. Shan's study (1974) on *Pleuroxus denticulatus* demonstrated that southern populations initiate gamogenesis at long photoperiod rather than short, and this seems true for the *Bullatifrons* species (and probably also *E. microdontus)* in the southern states. Chien (1969) illustrated a male (mislabelled female) of *Bullatifrons* from Mississippi collected on 10 May 1967. One of two specimens collected by Bunting in the Santeetlah Reservoir, N. C., on 25 May 1969 (Table 1) was gamogenetic. A population from near Clarendon, Ark., was gamogenetic on 30 March 1959. In early May 1974 populations in a pond near Reelfoot Lake, Tenn., and in Courtebleau Bayou, La., were gamogenetic, although populations at Chien's localities in Mississippi were parthenogenetic. These are all the known records for gamogenesis of *Eurycercus* in the southern states. They strongly suggest that gamogenetic individuals of *Eurycercus* (and probably other Cladocera as well) in the lower North Temperate latitudes should be looked for in the spring during increasing photoperiod rather than in the autumn.

d) *Distribution and abundance*

Although the genus *Eurycercus* is widespread in the southern United States, the species *E. microdontus* is presently known only from localities within 300 km of the Atlantic and Gulf coasts, all the more inland records being of *Bullatifrons* sp. (Fig. 1). *E. microdontus* occurs in quite large lakes (Lake June in Winter, Lake Jackson, and White Lake) as well as in smaller water bodies of the farm-pond variety (the two localities of D. L. Dycus in Georgia). Because there have been very few studies of Cladocera in this part of North America, the records are only suggestive of the actual distribution and abundance. I suspect that the smaller water bodies, such as ponds, backwaters, slow streams, etc., particularly those with an abundance of macrophytes, and hence some protection against predation by fishes, will yield many records of the species when they are studied intensively.

ACKNOWLEDGMENTS

Field work in southern Florida in 1960 based at the Archbold Biological Station and again briefly in December 1972 was supported by NSF grants G-6157 and GB-29725, respectively. Many persons contributed collections or information used in this study. I am particularly indebted to R. V. Harmsworth, W. M. Lewis, Jr., M. C. Whiteside, Pamela Patterson, D. C. Wade, D. L. Dycus, P. R. Becker, E. L. Hanebrink, Dewey Bunting, and F. N. Young for assistance specified in Table 1 or in the text. The more-than-twice-as-many other persons contacted, although sympathetic and anxious to cooperate, were unable to provide any specimens or records of *Eurycercus* from the South. Their good wishes and understanding are also appreciated.

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